INSTITUTE FOR FISHERIES RESEARCH
DIVISION OF FISHERIES
MICHIGAN DEPARTMENT OF CONSERVATION
COOPERATING WITH THE
UNIVERSITY OF MICHIGAN

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August 28, 1946

REPORT NO. 1064

VALIDITY OF SCALE METHOD FOR AGE DETERMINATION IN BROOK TROUT FROM HUNT CREEK, MONTMORENCY COUNTY, MICHIGAN

by

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During the month of August, 1939, one thousand wild brook trout were seined from the headwaters of Hunt Creek for a marking experiment. These fish were all assumed to be young of the year, sorted on a basis of size, and for the purposes of this study are assumed to have been born during the month of January, 1939. These fish were individually measured as to total length and an average weight obtained by weighing the entire lot. At periodic intervals subsequent to the release of these fish in the same portion of the stream intensive seining was conducted with the purpose of recovering marked fish. Most of the recoveries resulted in this manner, but a few were caught by hook and line fishermen. At the time of recapture, the total length was recorded and a scale sample taken. This present study is based on the 175 fish recovered over a period of 46 months after release of the marked fish.

The scales were cleaned and mounted in glycerin-gelatin medium. Age determinations and scale measurements were made using a scale projection machine. The magnification used was 90.7 diameters.

Body-scale relationship

One of the premises upon which the scale method is based is that the scales grow in some measurable proportion to the growth in length of the fish. It is recognized that certain comparable scales, usually designated as "key-scales" should be selected and that these scales should be taken from the same position on each fish. Due to the obvious difficulty of designating "key-scales" to be used in brook trout, a comparison of the scales taken in the normal sampling method was attempted. These are usually obtained from the left side of the fish anterior to the dorsal fin and between the median dorsal line and the lateral line. This comparison was not at all successful, scales from this region of the same fish differing in their measurements as much as 65%. Belding (1934) working with the parr of Atlantic salmon in Canadian rivers was able to use successfully both the anterior scale radius and anterior-posterior diameter of the scale in computing previous growth history. The scales were obtained from much the same area as in our study but the average measurements of 10 scales were used in the computations. Similar results might be obtained for brook trout using a restricted area for sampling and a large number of scales from each fish.

Scale growth and annulus formation

The scales of brook trout are minute thin plates of a hyaline substance, the outer surface of which is covered by fine concentric ridges or circuli. The scales are cycloid in character with the anterior-posterior dimension being usually greater than the dorso-ventral dimension. The anterior two-thirds of the scale is imbedded in a pocket in the skin and, as compared with the posterior portion, shows more distinctly the circuli or ridges on the surface of the scale. The character and appearance of the circuli of the scales of most species of fish have been used

by most workers as the indices for age determination. The characters most often used to identify the year marks are the following: (1) cutting-over or crossing-over of circuli, (2) incompleteness or discontinuity of circuli, and (3) relative approximation of successive circuli. The value of these three characters in age determinations of brook trout are summarized below.

(1) Cutting-over of circuli does not appear to be very helpful in age determinations of brook trout. The successive cutting-over of two, three, four or more circuli that is so apparent in many centrarchid scales has not been observed in brook trout. Annuli may be accompanied by a crossing over of one circulus, but this commonly occurs also in other parts of the scale not associated with an annulus.

(2) Incompleteness or discontinuity of circuli is often apparent and is usually associated with the formation of an annulus. The circuli may even be complete in this area, but are very indistinct, thin lines or weakly calcified ridges, markedly different from the heavy lines or circuli of rapid growth.

(3) Relative approximation of successive circuli is perhaps the best character upon which age determinations may be based. The variability with which this appears determines the degree of accuracy with which age determinations may be made. In some localities the circuli formed in summer are 2 or 3 times as far apart as the winter circuli, thus forming easily recognized bands of summer and winter growth. In other localities there is no abrupt change in the rate of scale growth and it is very difficult to distinguish any areas on the scale that could be interpreted as winter and summer growth. When this occurs, the discontinuity or incompleteness of circuli is also usually lacking, thus rendering age determinations doubtful.

Age determination of brook trout by the scale method depends primarily on the characteristic formation of the circuli. It would be highly desirable therefore to obtain more precise information concerning the factors responsible for or influencing the formation of these circuli. This formation of the circulus may be resolved to two factors acting simultaneously (1) the effect of an increment of scale growth on the deposition of a circulus and (2) the effect of a time element on the deposition of a circulus. The reasons for this assumption are as follows.

Plotting the number of circuli on the scale against the total length of the fish indicates a considerable degree of correlation.[1] From this it would appear that as the scale grows in proportion to the length of the fish, the circuli are deposited on the scale as a result of some increment of growth. More circuli are usually laid down in late spring and summer when the majority of scale growth occurs than in the fall, winter, and early spring when scale growth is at a minimum. If the increment of scale growth was the only factor responsible for the deposition of circuli, the spacing of the circuli should be equidistant from each other. However, in most cases there is considerable variation in spacing of the circuli. This variability in spacing of the circuli indicates that there is also a time element involved in the deposition of circuli. If the time element was the only factor involved, there should be more circuli formed between October and May than between June and September. This is not generally true. Therefore, it seems logical to assume that circulus formation is a result of the interaction of both an increment of scale growth and an interval of time.

The relationship between body growth and scale growth is most essential to continued studies of age determination in the brook trout as is information relating to the factors influencing body growth such as tem-

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[1] Figure 1.

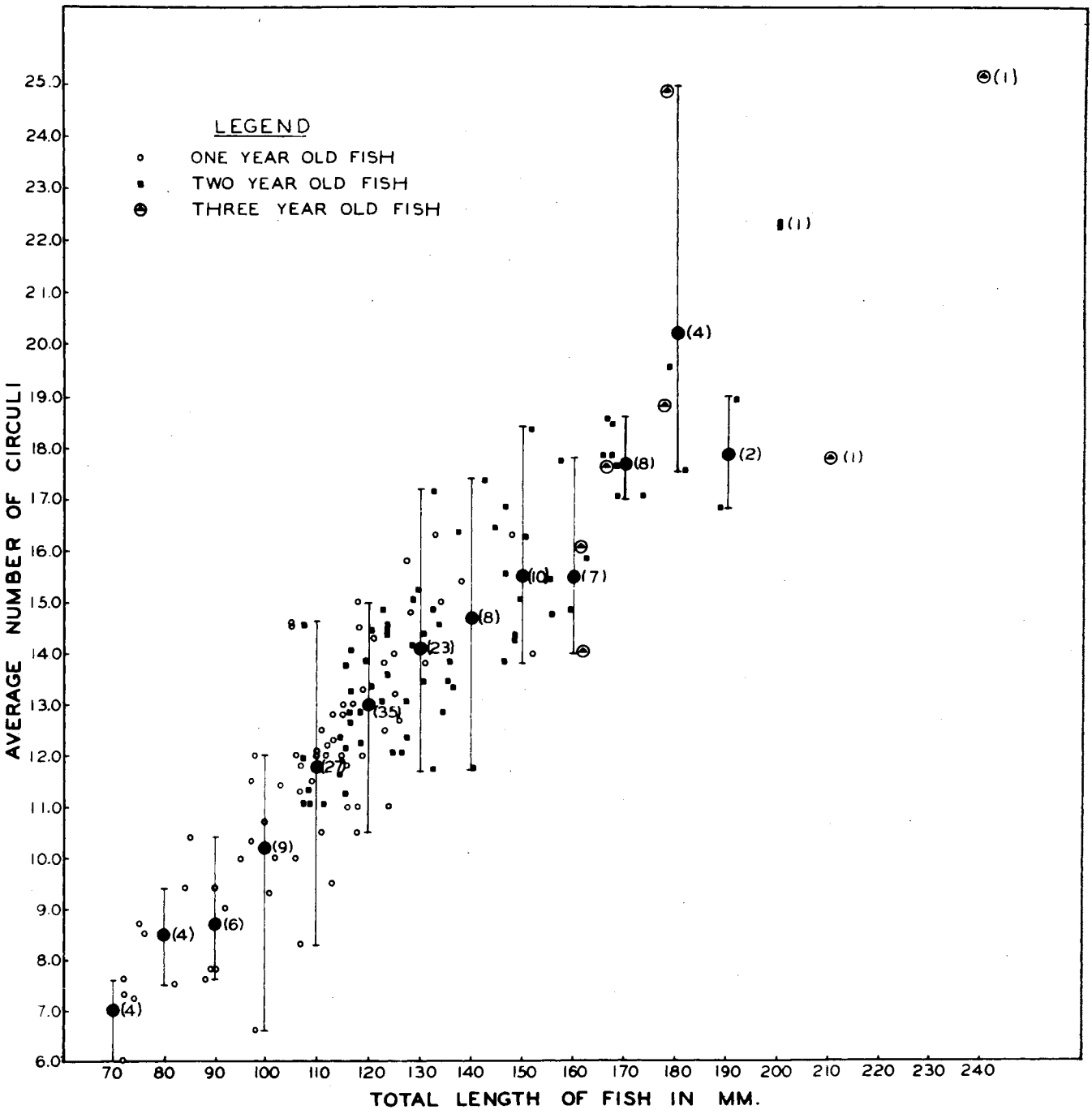

Figure 1. Relationship between total length of fish and average number of circuli on scales of known-age brook trout in Hunt Creek. Large dots represent averages and vertical lines represent ranges of 10-m.m. length groups.

perature, food and possibly the chemical composition of the water.

Time of annulus formation

In Hunt Creek in the spring of 1940 the annulus formed on the brook trout collected sometime between April 24 and July 2. Samples taken on the first date showed two or three closely approximated circuli on the outer edge of the scale, typical of winter growth. Samples taken on July 2 exhibited 3-5 widely spaced circuli outside the two or three closely spaced ones, typical of fast summer growth. In 1941 more samples during the critical months were obtained. On April 23, 24, and 27 samples indicated no fast marginal growth. In samples taken on May 22 from none to three widely spaced marginal circuli appeared and in samples of June 28 from two to five widely spaced marginal circuli were seen. From these somewhat meagre data we may tentatively conclude that the annulus is formed during the latter part of May or early June. Further observations on the scales through the fall, winter, and early spring months revealed that very little scale growth occurs during this time. Thus the effective growing season in Hunt Creek is limited to little more than three months of the year. This has been substantiated by comparing the average lengths of samples of fish taken during different months. Average lengths show marked increments of growth during the period of May to August with little change during the remainder of the year.[2]

Age group composition of recoveries

The known age group composition of the fish at the time of recapture was as follows: 76 fish were collected during their second year of life, 85 in their third year, 12 in their fourth year, and 2 in their fifth year. For the most part these figures represent comparable recoveries based on equal amounts of collecting effort, though the catchability of different

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[2] Figure 2.

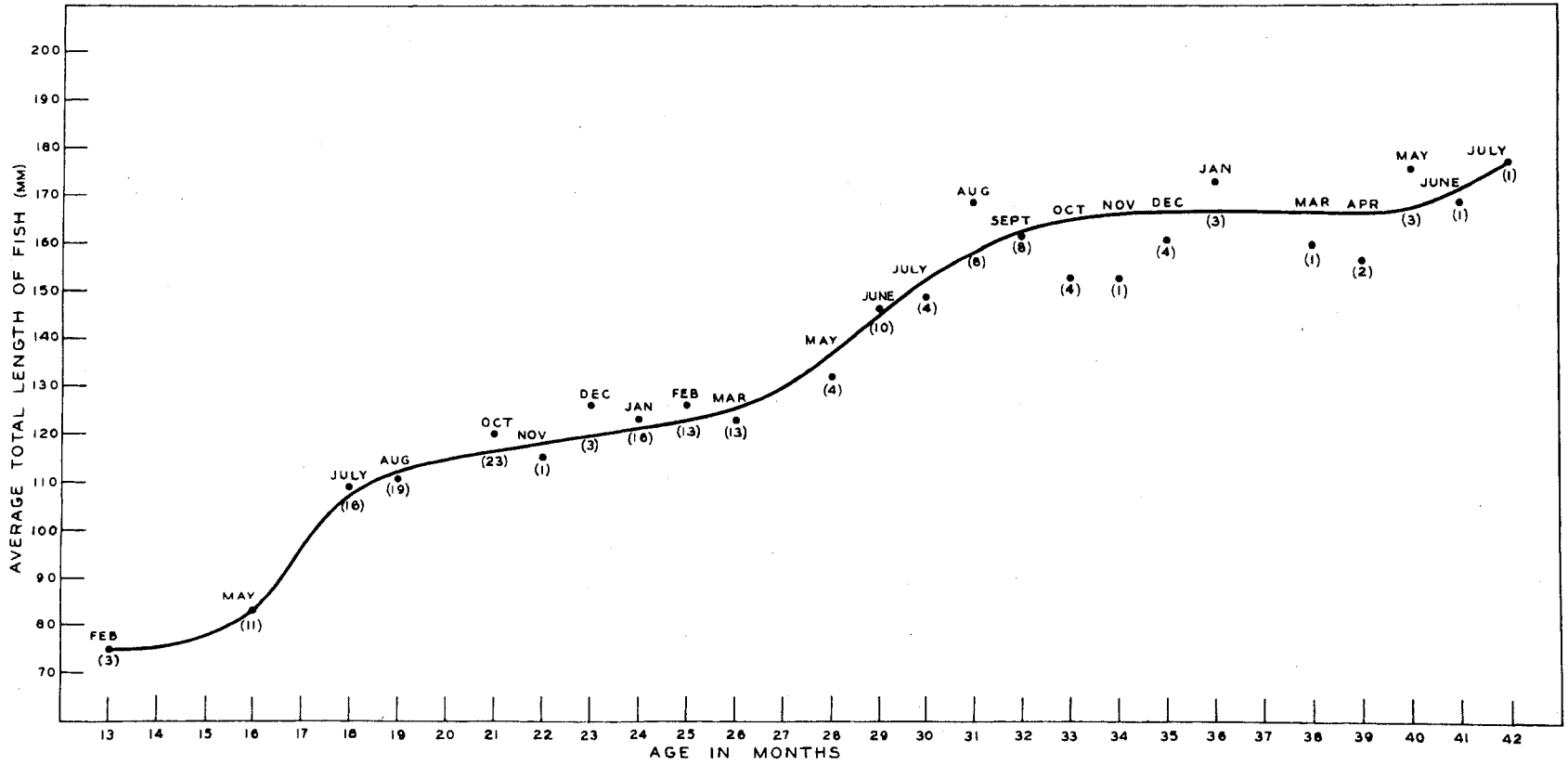

Figure 2. Average rate of growth of known-age brook trout in Hunt Creek.

age groups probably is not the same. However these figures might possibly be used as a rough estimate of age group composition of the population present.

Validity of age determinations

Based on the present study, it is estimated that 80 to 90 percent of the fish in age groups I and II can be aged correctly. Of the 11 individuals studied in age group III, seven were recovered before the formation of the third annulus but showed two characteristic annuli and a summer and winters growth outside the second annulus. Of the remaining four individuals in age group III only two exhibited three definite annuli. In age group IV neither of the two individuals exhibited four annuli definite enough for age determination. It is concluded from this study that age determinations past the formation of three annuli is highly doubtful in these waters. It should be emphasized, however, that other bodies of water with different conditions might produce fish with scales that are readily aged throughout the life of the fish.

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